

Being a Propulsion Engineer at JPL  
Dr. Ashley Chandler Karp  
Jet Propulsion Laboratory,  
California Institute of Technology



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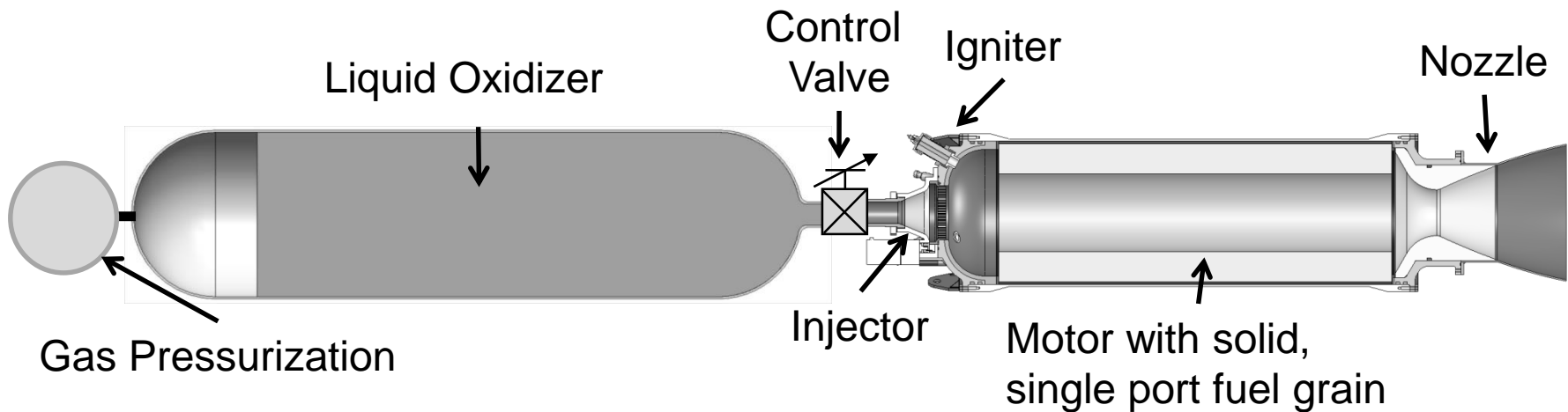


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# What is a hybrid rocket?

- Hybrid rockets typically utilize solid fuel and liquid oxidizer.

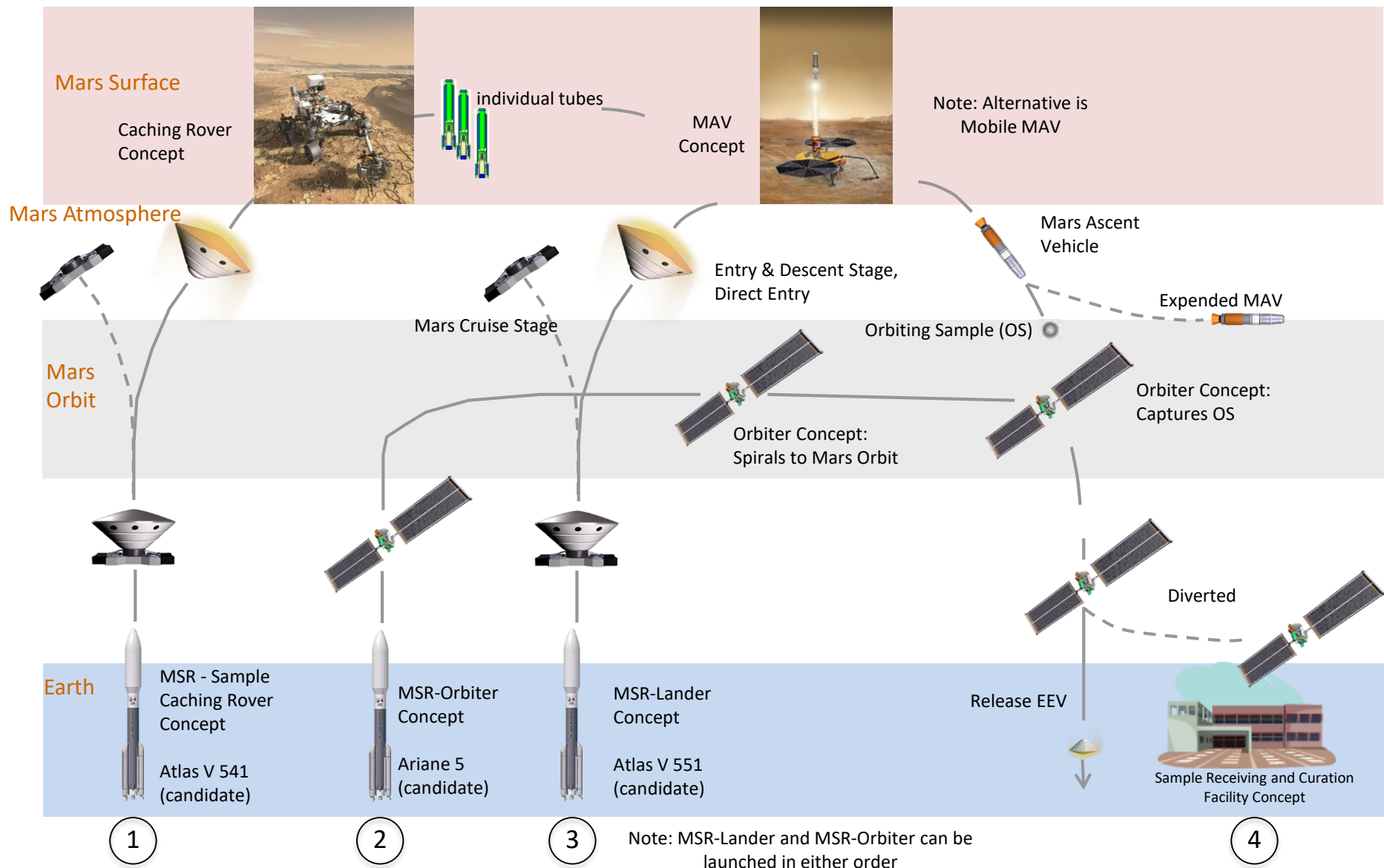




# Notional MSR Reference Architecture



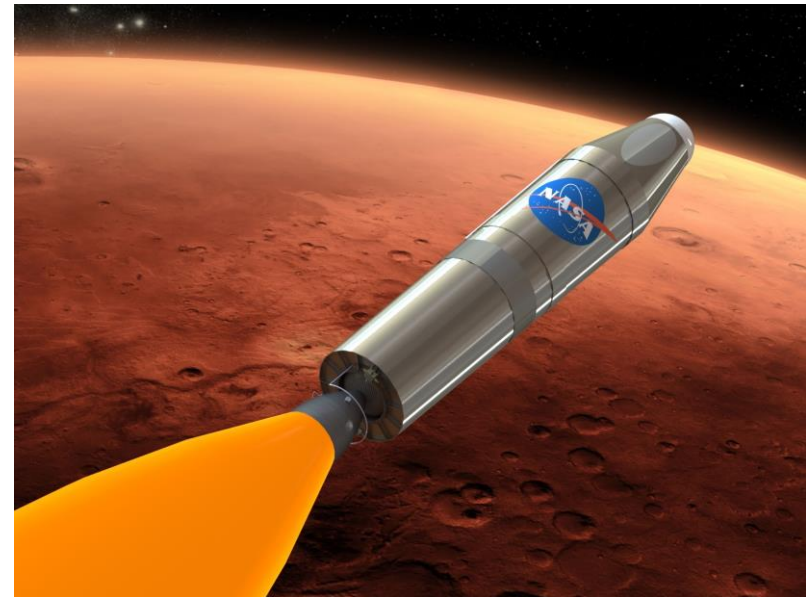
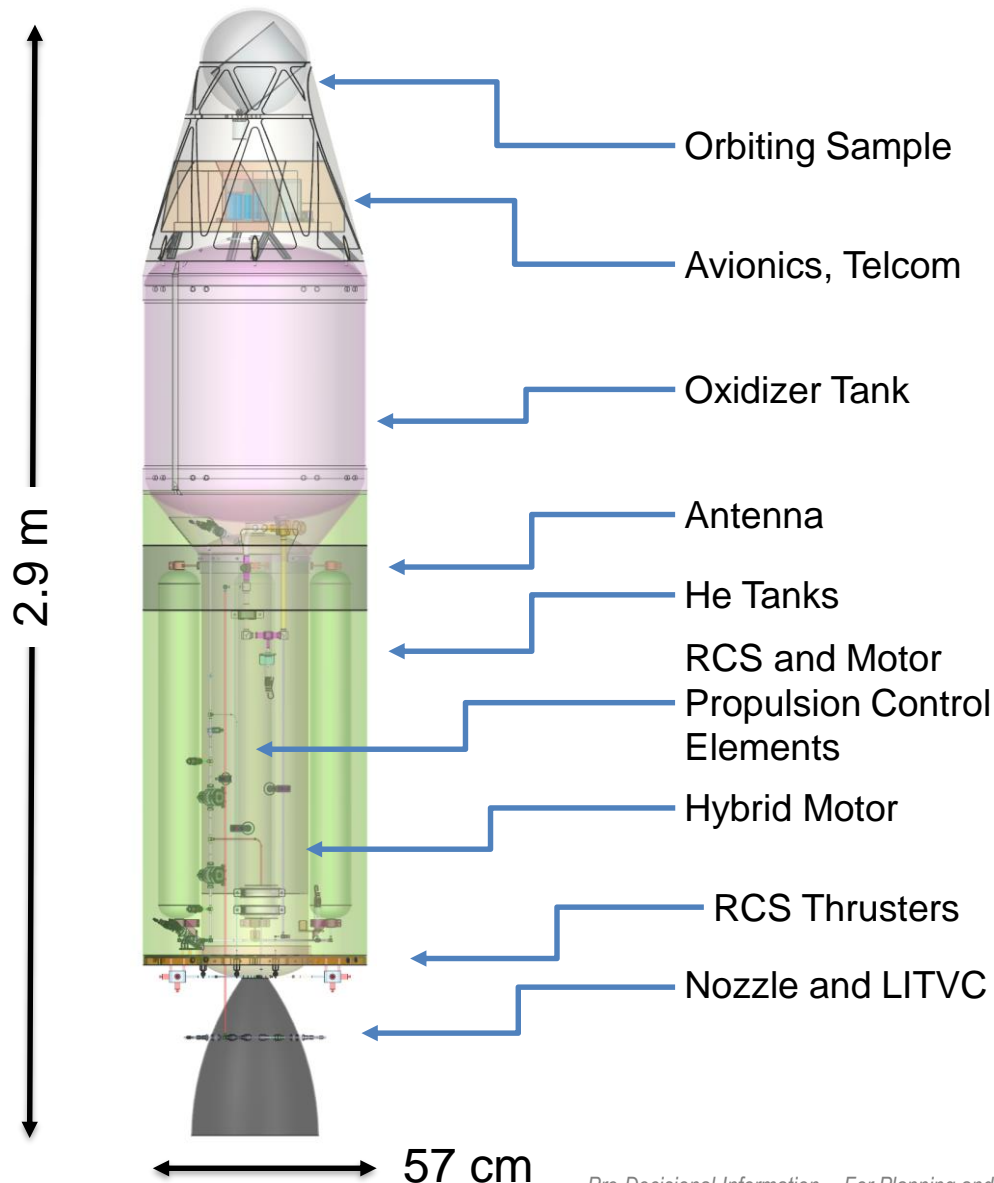
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# MAV Baseline Concept



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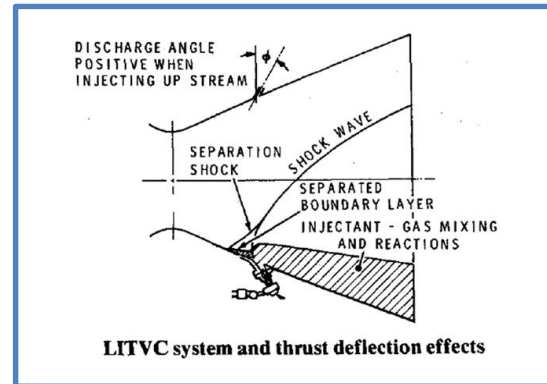
- Mass: 346 kg
- Hybrid propulsion system with **MON30 (70%  $N_2O_4$  + 30% NO)** oxidizer and **SP7, wax-based**, fuel.
- The propellant combination allows for storage temps as low as **-72 C** (low power)

# Areas of Technology Development

## New Hybrid Propellant Combination



## Thrust Vector Control



## Hypergolic Ignition



While the hybrid option showed the most promise, it is also the lowest TRL.

# Hotfire Testing & LITVC

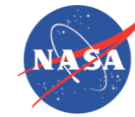


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## WHITTINGHILL A E R O S P A C E

MAV Heavyweight Motor #1  
Burn 2, with Liquid Injection TVC Events  
Duration 21.5 seconds  
September 7, 2017

# Hypergolic Ignition



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**Pellet Testing**  
**March 30, 2016**

**Nitrogen Tetroxide at 15°C**  
**SP7-based Pellets**

**Panasonic 4K at 30 fps, resolution:**  
**3840x2160**

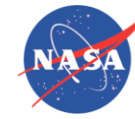
Dr. T. Pourpoint ([timothee@purdue.edu](mailto:timothee@purdue.edu))

Purdue University - 2017

**PURDUE**  
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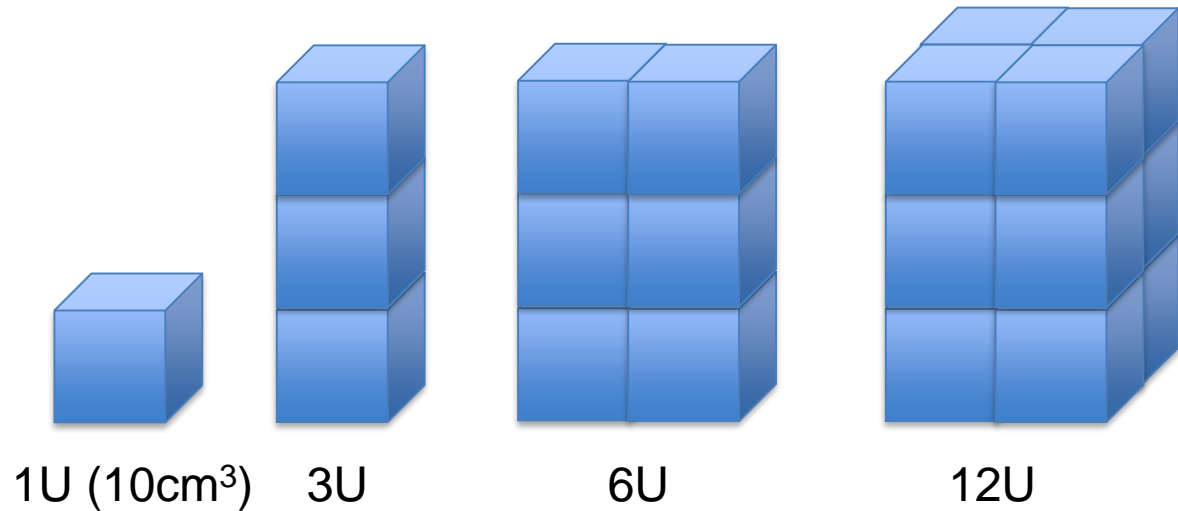


# CubeSat: Flight Design Concept

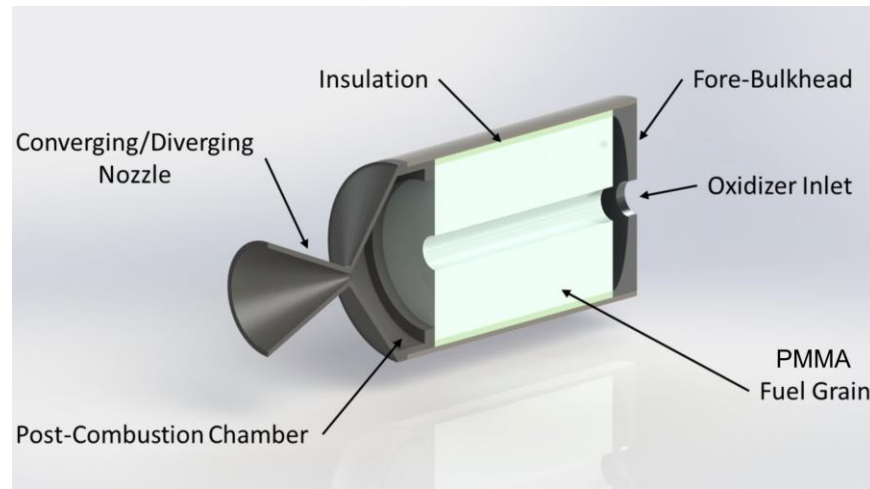


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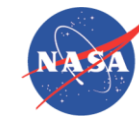
Goal: Small  
Interplanetary  
Spacecraft



Multiple  
motors are  
configured to fit  
within 12 U  
CubeSat

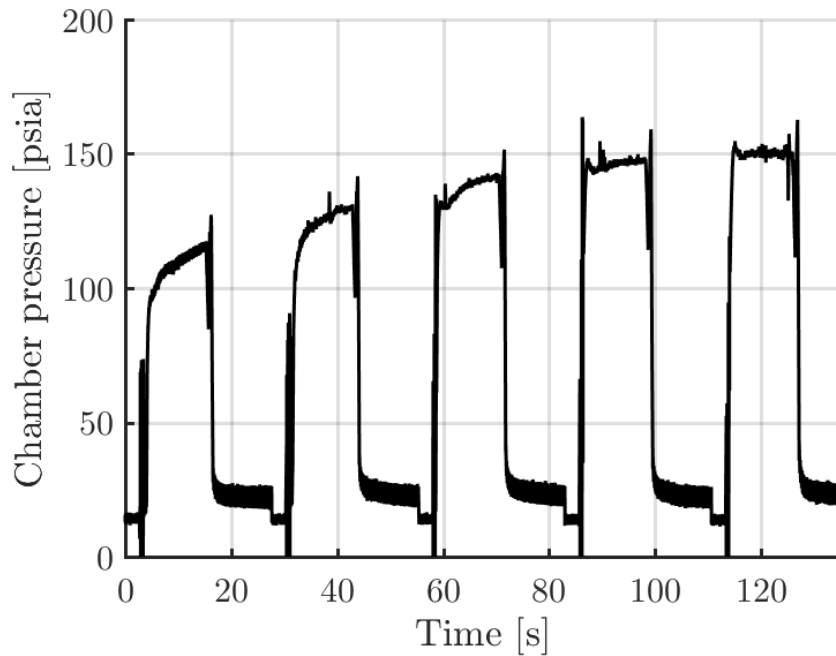


# Development Testing



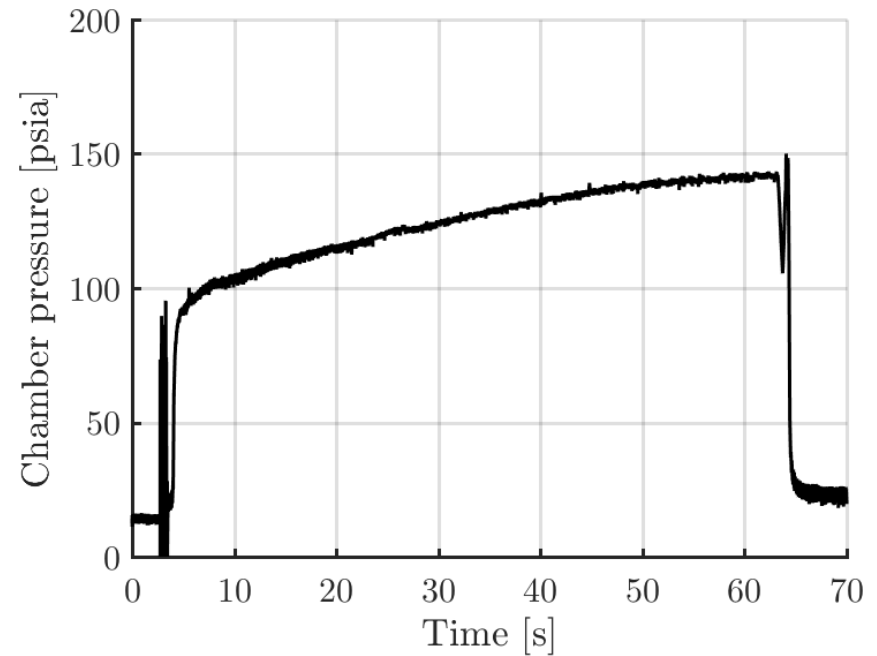
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Multiple Ignitions (Test 69)



TCM's and Orbit Maintenance

Long Duration Burn (Test 70)

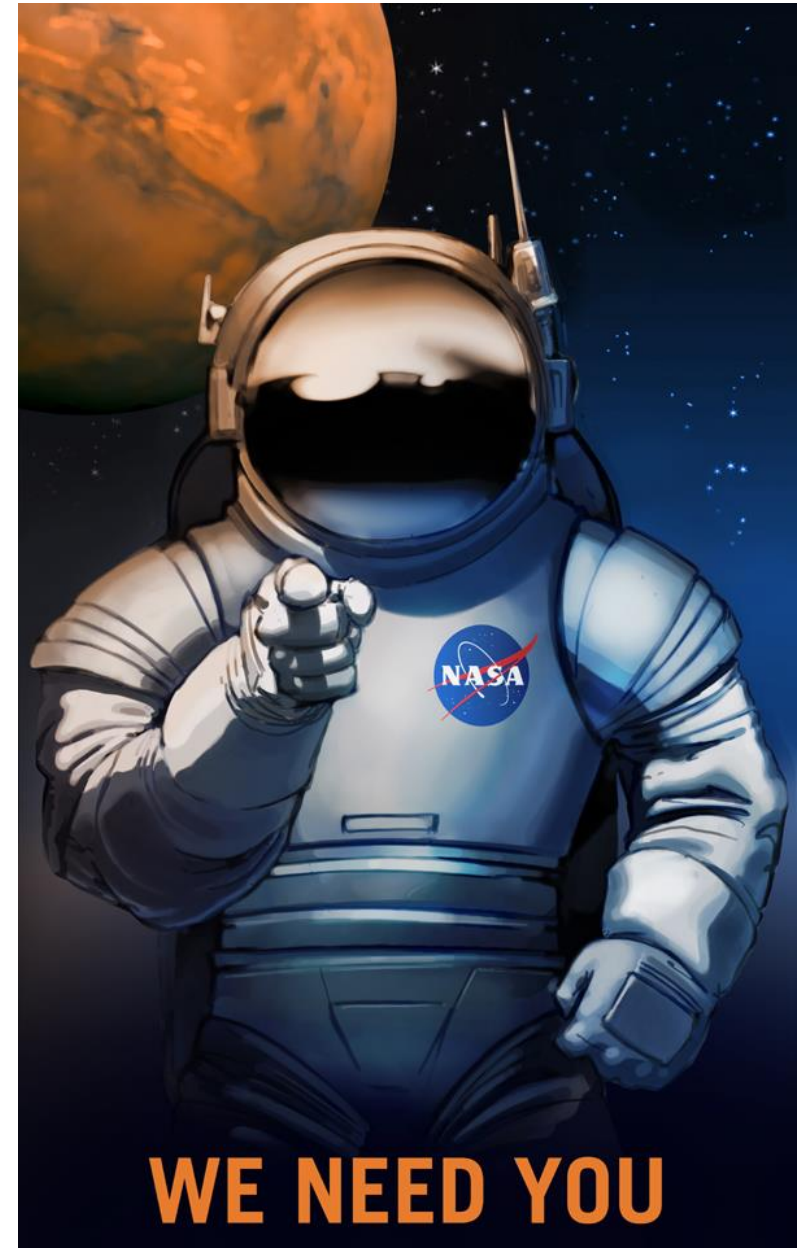


Orbit Insertion

# Questions?



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# Five Ignition Demonstration

Test 69





# Single Ignition



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Test 70

